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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

SAGAR, KRIPA

ART UNIT PAPER NUMBER

1756

DATE MAILED: 09/29/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/978,155

Applicant(s)

HUNG, CHI-YUAN

Examiner

Kripa Sagar

Art Unit

1756

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 October 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-14 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-14 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 October 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 4,6,8,10,12,14 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The term "thin enough" in claims 4,8,12 and "thick enough" in claims 6,10,14 are relative terms which render the claims indefinite. The terms "thin enough" / "thick enough" are not defined by the claims, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention.

The second (upper) resist is claimed to be "thick enough" to be an etching mask for a later etching. The etching process is dependent on factors such as selectivity with respect to the first resist and/or the substrate layer to be etched and the etching conditions. No guidance is provided in relation to these variables. Thus the thickness of the masking layer would be infinitely variable based on the combination of factors.

The first resist is claimed to be "thin enough" to avoid footing formation. This phenomenon is attributed to acid diffusion and hence controlled by the exposure dose, post exposure delays and the time and temperature of baking. The thickness of the layer can take any value based on the variable factors.

The bilayered resist process has a number of diverse applications wherein the demands on the resist layers differ. Accordingly, the thickness and relative thickness of the two layers differ significantly and no art-accepted standard exists. Further, the invention is directed to a method of patterning which eliminates or reduces footing -- thus one of ordinary skill in the art would recognize the *need* to coat the resist to a thickness that would reduce footing—but would not find any help in the instant specification with respect to the method. In light of this the terms "thin enough" / "thick enough" do not describe the scope of the invention.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1-14 are rejected under 35 U.S.C. 102(b) as being anticipated by US Pat.6107006 to Chang.

The invention recites a bilayered resist wherein the resist layers have differing photo-speed and contrast. This, it is asserted, prevents footing and T-top formation on the patterned resists.

Claim 1 recites a first resist layer suitable for trench formation and a second resist suitable for iso-line disposed on top. The bi-layered resist is patterned lithographically. Dependent claims 2-6 recite acid-diffusion rates in the two resists, the thickness of the resists and the contrast.

Claims 7-14 recite similar limitations.

Chang teaches a method of reducing pattern distortion in a chemically amplified resist pattern. The first resist is a chemically amplified resist coated to a thickness of up to 1.5 μm . A second resist which generates a carboxylic acid on exposure (2;36-47) is coated to a thickness of up to 600Å. The resists are photolithographically patterned. This prevents pattern distortion (3;6-35). The first resist is a chemically amplified resist hence the generation and *diffusion of acids* is implicitly faster than in the I-line resist. The *thickness* and the baking treatments also eliminate distortion (*footing*) at the base of the chemically amplified resists. The *thickness* of the upper resist layer is selected to etch the first resist layer providing straight side-walls (Fig.2). Chang teaches that any resist with a photoactive compound which generates an acid upon irradiation may be used as an *imaging* (second) resist with high *contrast* (3;36-43).

5. Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by US Pat. 4770739 to Orvek et al.

Orvek teaches a bi-layer photoresist process. A first resist layer sensitive to UV is overcoated with a thin imaging layer sensitive to DUV radiation. The layers are photolithographically patterned. The lower layer having superior etch resistance is suitable for trench etching. The more sensitive imaging layer permits better resolution (abstract). The requirements of the resists are defined in detail (7;1-67). Both layers may be sensitive to DUV or UV (8;37-52).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claim 1 is further rejected under 35 U.S.C. 103(a) as being unpatentable over US PG PUB 2002/0182514 to Montgomery et al. in view of Orvek

Montgomery teaches a method of reducing distortions in DUV resists. Using two chemically amplified resists for this purpose is known in prior art (#0016). Montgomery teaches a bilayered resist system comprised of a bottom anti-reflection coating (BARC) and a top imaging resist. The BARC includes a photoacid generator (PAG) sensitive to the radiation which is used to expose the top layer. Another DUV resist may be used for the BARC (#0022). The generated acid neutralizes any basic elements at the BARC-substrate interface thereby eliminating footing. Further the BARC suppresses internal reflection and reduces notching and t-top formation (#0042 --- #0044 & #0082)

Montgomery does not teach: use of a lower layer suitable for trench and an upper layer suitable for iso-line etching. The thickness of the layers is selected for the desired application – BARC and imaging.

Orvek teaches a bilayered DUV resist system wherein the layer thicknesses are selected for a differing application – trench etching and imaging. The thick lower layer absorbs the radiation and prevents reflection similar to a BARC (2;67-3;1).

A skilled artisan would adjust the thickness of Montgomery's lower resist layer and upper resist layer according to the need as taught by Orvek. This would have been obvious to one of ordinary skill in the art at the time the invention was made because Orvek teaches that a thin imaging layer overlying a thick etching layer provide the combined features of high resolution imaging and high aspect ratio etching at a lower cost and higher speed (3;2-5).

Conclusion

8. In the specification and claims, a distinction is made between a *trench* and an *isolated line* for patterning. As depicted in instant fig.2 an *isolated line* 130 would necessarily be surrounded by a *trench* and both would require the same patterning parameters. In contrast, the *dense line-and-space* pattern 140 would require high resolution imaging along with steep sidewalls, which single-layer resists do not provide. Clarification of the terms "trench" and "iso-line" is sought.

Examiner further notes the specification of resist characteristics for "trench" patterning and "iso-line" patterning (p.2; ll.19-26). The former requires "fast photoacid diffusion rate and a low contrast ability" while the latter requires "a slow photoacid diffusion rate and a high contrast ability". It is assumed that the diffusion rates of the photoacids are related to the thickness of the resist layer required for high aspect ratio trenches and isolated lines with lower aspect ratios. However conventionally, *contrast* is defined as the ratio (of the log-dose) of the exposed and unexposed areas and measured by the slope of the ILS curve (see Handbook VLSI Lithography : p. 734; fig.

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16- attached). The contrast thus defines the slope of the sidewalls of features – normally desired to be steep (Handbook of VLSI Lithography; p.733-734). Dense features would require higher contrast. The specification of high and low contrast for the two resists is not clear.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kripa Sagar whose telephone number is 703-605-4427. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark F Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

A handwritten signature in black ink, appearing to read "Mark F. Huff", with a long, sweeping horizontal line extending to the right.

MH/ks

**MARK F. HUFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700**